E/CONF.39/A/90
10 Oct.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item: A.2

Hungary

SOME ASPECTS OF INTEGRATED RIVER BASIN DEVELOPMENT IN LESS DEVELOPED AREAS

By Prof. Dr. E. MOSONYI,
Corresponding Member,
Hungarian Academy of Sciences,
Research Institute for Water Resources,
Budapest, Hungary

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

NOTES

1. Papers selected for inclusion in General Sessions will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

2. Papers selected for inclusion in Specialized Sessions will be available at the Conference in only one of the above official languages.

3. Summaries of all papers, as submitted by contributors, will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

4. Papers and summaries will not be available for general distribution in advance of the Conference. They will be published in advance in limited quantities only for the use of delegations of participating governments and of other authorized participants. Post-Conference publication and general distribution of the Conference Proceedings will follow United Nations practices as laid down by the United Nations Publications Board.

SOME ASPECTS OF INTEGRATED RIVER BASIN DEVELOPMENT IN LESS DEVELOPED AREAS

by
Prof. Dr. E. Mosonyi
Corresponding Member, Hungarian Academy of Sciences
Research Institute for Water Resources
Budapest, Hungary

Introduction

1. For the multi-purpose utilization of river basins situated in economically less developed areas, different preparation methods and implementation schedules are desirable from several aspects as for the development of river valleys in more advanced territories. A number of important differences can be established which are to be considered in the course of planning. It is quite obvious that the guiding principles as regards the integrated river basin development should be primarily drawn from experiences and results afforded by realizations in more advanced areas. The conclusions, however, will be correct only, if the special aspects are clearly established which are to be taken into account when a plan for less developed areas is to be prepared. These differences are pointed out in brief in the following. Further an example of a master plan developed for an entire country will be given, and finally some conclusions will be drawn. Questions of financing are not dealt with in the paper.

Main Differences in Physical and Social Conditions when Comparing Plans for Advanced and Less Developed Areas

2. Natural conditions in less developed countries are explored to a lesser degree, even the important physical data may be completely lacking. This disadvantage, however, should be made up at least to a degree that the preliminary over-all plan of the integrated utilization of the river basin could be prepared with satisfactory accuracy, or in a way that the economical conclusions drawn from the plan should be correct in their principles. Therefore, the most important observations, measurements, explorations and scientific researches should be performed at an increased pace, in order to elaborate the studies relating to the distribution of water resources and the storage thereof within relatively short time, yielding the balance of supplies and demands. This aim, however, can only be achieved if exploration and research work is carried out by multi-phase development. In other words, this is to be understood that any branch of research should not be developed in the first stage to the degree necessitated at

a later stage for the formation of the final plan, since this would involve excessive time and cost, hindering the preparation of a preliminary plan necessary for the decisions to be made. On the other hand attention should be paid that, in any stage of planning, no branch of the necessary investigations should be overdeveloped at the expense of otner branches. Last but not least the most important point, the relative urgency of research work and consequently the resulting order of the same should be mentioned. In this respect the professional prejudice of the representatives of the individual branches of science must not prevail, and the realization of this aspect rests with the group of experts directing the work. It is easy to give an example: it is to be avoided to perform a more detailed soil - mechanical or geological investigation at the possible sites of major installations as long as the informative magnitude of water resources and the estimated value of the water balance is not available. Thus, the precedence of informative meteorological, hydrological and topographical investigations /surveying/ becomes obvious. Furthermore, within hydrological investigations the preparation of detailed measurements should not be commenced, before on basis of precipitation data and informative measure - ments approximate hydrological pattern of the river basin is obtained. This will notably decide upon the density and type of the observation network to be established at a later stage. Attaining, however, a certain degree of hydrological exploration, it is desirable to perform informative geological, pedological and other investigations in order to obtain a clearer picture to what degree the utilization of available resources is permitted by other natural conditions /e.g. the reasonable height of large dams and the storage capacity thereof possibly per - mitted by topographical and geological conditions/. The time of preparing the preliminary over-all plan to be submitted to the government for their first decision should not be too long and the cost estimate thereof is also limited. Otherwise government factors would refrain from the preparation of the same; should it become manifest in the course of work that the preparation of the plan is far too prolonged or would involve a considerably greater investment as envisaged, the planning work alltogether may come to a standstill. Annex I of the United Nations, Department of Economic and Social Affairs publication, No. E/3066 gives a very valuable guide to the organization of basic research [1].

3. Protection works against damages caused by water are or rather were more or less completely realized in advanced areas usually a long time ago, since one of the most important pre - requisites of economical development in general is that settle - ments, industrial plants, mines, communication networks and agriculturally valuable lands should be protected against inundations, logging waters, excessively raising groundwater, and that marsh - lands should be drained. In addition the various utilization of waters /irrigation, navigation, hydroelectric power production and possibly pumped storage, industrial and domestic water supply, fishponds, use of medicinal and mineral waters, recreation and sports/, further soil conservation, protection against erosion, and reforestation, etc. was observed. In highly developed areas at present waste water and sewage treatment constitutes in general the greatest task.

4. In the river valleys of less developed areas mainly the signs of protection against water damages /chiefly flood control/ can be recognized, and these are mostly of local character. It is quite natural, however, that less developed countries being al - ready in a relatively more advanced situation, based on ancient traditions and newly established installations, smaller or greater irrigation systems came into being and simple local solutions of supplies meeting other demands can also be found.

5. It follows from the foregoing that development recommen - dations prepared for less developed countries should comprise the plans to meet the requirements of basic flood protection and drainage, and those of water projects for a more advanced economy as well. Thus the plan should enable to make up for the time lost due to lesser development, which imposes great responsibility on those preparing the plans, since the possible economical and social development should be reckoned with with the utmost fore- sight.

6. It is irrefutable at the same time that in less developed areas physical and social inhibitions are smaller /less developed settlements, small density of population in individual valleys, scarce communication network, lack of major structures, etc./ af- fording greater liberty to experts and designers. From this statement it also follows that, in general, more alternatives can be elaborated as compared to those regarding the further develop- ment of more advanced river valleys. Besides the alternatives on major installations arrangement may differ to a greater extent from each other. These circumstances, however, are also of ad - verse effect, making more difficult and causing delay in govern- ment decisions.

7. In the various phases of planning and implementation more modifications and alterations must be reckoned with in less develop- ed areas as compared to those encountered in advanced areas. In the former case, notably, at the beginning of planning less accu - rate data are available as regards the physical, social and other conditions of the river basin.

8. Besides technical and scientific aspects the type and gener- al arrangement of major hydraulic structures in less developed countries may be strongly influenced and modified by social con - ditions, primarily by skilled labour available and the number of qualified hands. Thus, e.g. the lack of trained workers may ne - cessitate that dams should be built as earth dams or rock-fill dams at sites, where, otherwise the erection of a concrete gravity dam would be indicated. Transport facilities exert the same in - fluence.

9. The requirement, that a satisfactory utilization of the first project to be built in the framework of the integrated river basin development plan for less developed countries should be com- menced after the commissioning thereof, calls for special fore - sight. Thus, e.g. in case of installing an irrigation project every preparation should be done for the efficient operation at the farms to be supplied with water. In this respect the follow- ing main facilities should be provided for: the internal techni- cal installations for irrigation and drainage, agricultural equip-

ment and materials, adequately trained agricultural hands. Further development has been frequently frustrated by the lack of necessary equipment and special knowledge. Failure in many instances, notably, was not attributed to the defective operation due to lack of sufficient knowledge, but to the incorrectness of the scheme. Instances can also be found where, because of failures occurred, due to miscarried irrigation, the futility of irrigation had been concluded, even irrigation had been discontinued. Such phenomena may completely paralyze the implementation of the integrated river basin development on account of the extremely unfavourable propagative and psychic effect exercised both on the population and responsible government officials. The urgency of the realization of the educational programme cannot be overemphasized. It is aptly stated in the United Nations expert's report already quoted: "Pilot schemes and demonstration farms should be developed wherever feasible in order to show what new possibilities may arise once the waterworks come into operation." /See /1/, par. 44, p.14/

10. In the course of developing irrigation projects, special care should be given to the development of drainage as well, lest logging waters on or salination of irrigated areas should occur. This directive applies also to more advanced territories, but, since drainage thereof had been commenced in olden times preceding the preparation of the up-to-date integrated development plan, the solution of the problem becomes simpler: the novel task is not more than the extension of the already existing drainage system to a lesser or greater degree.

11. It should be eventually stressed that between countries termed collectively less developed areas, there is a gradual transition towards the more advanced ones, moreover, even within one country river valleys exploited to different degrees can be found. In the course of organizing research work and the preparation of the development plan it is of high consequence to what degree the river basin concerned is developed at that time.

12. In less developed areas research institutes and design bureaus to be entrusted with the elaboration of the final development plan and detailed designs are generally absent, or if any, they are usually working in narrow frames. The organizations existing in more advanced countries can be more easily developed for the solving of some new tasks.

Utilization of the Experiences Gained in Advanced Areas

13. With a novel task occurring in less developed areas, the experiences gained with river basin schemes already implemented or under way in various parts of the world, should be made use of to advantage. Obviously commissioning governments and experts entrusted with planning work are primarily interested in developments realized in areas situated geographically near or having similar climatic conditions. However, to achieve optimum solution it is most desirable to extend studies to other remote river valleys having possibly entirely different climate, if similarity in some respect can be found therein. From seemingly remote cases some use-

ful experiences may be gained or valuable conclusions and lessons can be drawn in the following problems:

- measurement procedures and instruments for the exploration of physical conditions, establishment of observation net - works,
- methods for the collection and evaluation of relevant data,
- organizational structure of research work, laboratories,
- methodological problems of scientific research,
- in individual branches of research, where similarity between the river basin to be developed and that under study is noticeable, the adaption of the final results is possible as well,
- design procedures, norms , standard specifications, standard designs,
- methods and organization of construction, mechanization,
- adaption of operation experiences,
- financial problems and methods of economic evaluation,
- education methods and training programme,
- possible examples for the collaboration between two or several countries,

and finally the methodology of the preparation and multi-stage development of integrated river basin planning.

14. Several multi-purpose water management plans have been implemented all the world over, about most of which - in detail as well as comprehensively - numerous descriptions can be found in books and periodicals, therefore the author dispenses with the enumeration thereof. Also summarizing studies have been published of which that of Kanwar Sain /2/ and K. L. Rao /3/ are mentioned.

15. Considerable assistance is rendered for the experts by the regional conference of the UN ECAFE organization /4/ and the manual /5/ published by the same. Also the publication of the said UN Commission dealing with flood protection as a problem of special importance /6/ or those enlarging upon the present state multi - -purpose development merit attention /7/, /8/.

16. It cannot be the intention of the author to review the international schemes within the frames of the present brief study, nevertheless he would wish to present just one example, notably the present state and development plan of Hungary's water management.

Development and Present State of Water Management in Hungary

17. To properly understand Hungary's water resources development plan, the historical antecedents as well as the present state of water projects should be known /9/, /10/.

18. Of Hungary's territory of 93,000 sq. km, some 24,000 sq.km, roughly one-fourth of the entire area, is protected against inun - dations caused by floods by levees. The overall length of protection levees amounts to about 3900 km. This work was begun as early as 1846.

19. River regulation work on Hungary's rivers is aimed at ensuring the unobstructed travel of floods, ice and sediment load, further at the creation of permanent navigation depth over major rivers. River training work in Hungary had been started in close connection with flood control. The big bends of the Middle-Danube have been cut through at 15 places in the period between the years 1820-1832, by which a shortening of 96 km ensued. Similarly regulation work on the Tisza River was initiated. The length of the river had been shortened by 112 cuts by 454 km in the period between the years 1840-1870. The travelling time of floods has been abated thereby from some 40 weeks to about 8 weeks. River training in Hungary extends at present to a 2400 km long river stretch of which 1300 km is navigable. The overall length of the regulation structures is 850 km.

20. Drainage control of the areas protected from the inundation of floods followed closely river training and levee construction. Prior to the development of drainage control, large areas were covered by logging waters during wet periods. Drainage control has been achieved by the following installations: a canal system of an overall length of 27,000 km, 252 pumping stations with an overall delivery capacity of 440 cu.m/sec, further 900 portable pumps having an aggregate capacity of about 230 cu.m/sec, about 400 pipe culverts and inlet gates crossing the flood protection dykes and some 20,000 small hydraulic structures in the canals.

21. The magnitude of the irrigated area at present amounts to 186,000 hectares from which 50 per cent is supplied by sprinklers. Some considerable results had been attained by irrigation. In irrigated areas an increase in crop yield from 50 to 150 per cent or even more could be achieved, as compared to that with dry farming.

22. Pisciculture is carried on in artificial fishponds for over a century. Fishponds have an aggregate surface area of 22,700 hectares at present.

23. Hydroelectric power generation is developed up-to-now on a low scale only, viz. at stations built on smaller streams. The high-capacity Danube project is under preliminary planning at present.

24. Some 66 per cent of the population of about 10 million is supplied with good quality drinking water. The aggregate capacity of waterworks serving the purpose of drinking water supply amounts to 820,000 cu.m/day, and of industrial water supply plants to 4.2 million cu.m/day. The most rapid development in the field of waste water and sewage treatment was witnessed during the last decade.

25. Eventually also works carried out over the entire territory of the country in the last fifty years in the field of the regulation of small water-courses, dewatering of marshlands, regulation of lakes, gully control and tile drainage should not be omitted.

Master Plan for Water Resources Development in Hungary

26. The first approach of the Master Plan for water resources development in Hungary had been elaborated on the proposal and under the guidance of the author between 1952-1954 /11/. The Plan had been supervised by the Hungarian Academy of Sciences and discussed on a conference of the same. The summarization of the Plan consists of ten parts /Vols. I-X/, ten supplements /maps, diagrams, etc./ and a synthesis /of two volumes/.

27. Special attention is paid to irrigation projects, and to avoid conflicts between water needs and available resources, even if the conflicts are of temporary nature, the "concept of tolerance" suggested by the author has been used. By this method the reasonably permissible reduction in specific water supply as related to optimum demand, is calculated for various plants to be irrigated. According to investigations in this field it could be stated that economical optimum can be attained, if irrigation projects will be designed for discharges which are available at a probability of 80 per cent, i.e. in 80 years from among 100. If such an assumption will be accepted, decrease in crop yield, even in most arid years, will not exceed the value of 10 per cent as compared to the optimum yield, and a multi-annual average loss in crop yield will be as much as 1 per cent only.

28. In the synthesis of the Plan a programme is given for explorations and research work to be carried out in the interest of further development of the plan.

29. The more detailed and improved development of the Master Plan being in progress under the guidance of the National Water Authority, will comprise 20 parts and accordingly will be summarized in 20 chapters /each of them compiled in one or more volumes/ as follows: I Aim and importance of water management in the national economy; II Natural conditions, available water resources of the country; III Flood control, control of lakes and river training; IV Drainage; V Improvement of small water-courses and control of the catchment area thereof; VI Irrigation; VII Pisciculture and fishponds; VIII Domestic and industrial water supply; IX Sewage of settlements and waste waters of industrial plants; X Protection against pollution; XI Waterways and ports; XII Reservoirs and multi-purpose use of stored water; XIII Utilization of mineral, medicinal and thermal waters; XIV Recreation, sports, nature conservation; XV Major hydraulic installations; XVI Questions of international nature; XVII Water balance of the entire country; XVIII Other problems connected with water management; XIX Relationship between development of water resources and other branches of national economy; XX Summary.

30. Since, in some regions of the country, surface water resources and storage possibilities as well are rather limited, high-degree utilization of groundwater resources, mainly by means of tube wells is envisaged. This aim, however, constitutes a considerable task for the Research Institute for Water Resources to establish the possible maximum yield obtainable from groundwater with-

out the hazards of non-permissible, even dangerous drawdown of the groundwater table. Therefore, groundwater table observations, pumping tests and mapping of groundwater conditions have been very carefully performed during the last decade, and research work on groundwater is even currently in progressive development.

31. To economize on irrigation water, i.e. to reduce specific water yield, a vigorous spreading of the sprinkling method is aimed at. The participation of sprinkling in the total irrigation, related to the irrigated areas, will be increased from the current value of 50 per cent /see par. 21/ up to 60 per cent even as soon as by 1965.

32. Economic evaluations are given separately in the individual chapters, based upon rough estimates of the investment and operation costs.

33. A rough approximation of cost allocation is attempted for the major installations of multi-purpose character.

34. The Plan provides for a development of 15-20 years or, in some cases, even for a longer time in the future.

35. More detailed Regional Plans will be developed from the Master Plan which work is already in progress at present. The boundaries of the so-called regions do not coincide with the watersheds in many instances, but are in conformity with some directives of econo-geographical nature.

Conclusions

36. On basis of the expounded general considerations, the numerous well-known international river basin plans and the results of the implementation thereof, further on the strength of direct experiences gained with the development in Hungary, the author feels encouraged to draw some conclusions which, possibly, may be considered in the further investigation of the problem in question.

37. Exploration, research work as well as the preparation of the integrated plan should be performed by successive approximation in several phases and in a proportionally progressing manner.

38. Prior to the realization of the first step, it is advisable to reconnoitre the river basin developments and national master plans already implemented or under way in broad field, in order to establish the factors on basis of which, due to the similarity thereof, adaptation appears to be indicated. Instances can be found, when the survey of some larger area unit of the world may permit the drawing of highly useful conclusions /12/.

39. Should alternative possibilities for the basic solution emerge in excessive number, the informative elaboration of the same must not be refrained of, not even in the case when the work would involve great efforts. This aspect cannot be stressed enough, since the insufficiently clarified counter-alternatives usually

"haunt" a long time, and the reappearance of the same at a later date may completely paralyze the designing work and even the realization of the scheme. The number of the alternatives, of course, assuming careful comparison, must be reduced according to possibilities in the course of the progressing elaboration of the plan, otherwise, having reached a certain degree, too many alternatives may render the work too cumbersome and involved, resulting even in a complete failure.

40. Since the preparation of the plan is a lengthy operation, it is desirable to select the major structures, if any, in the course of elaboration already, which will fit to any of the development alternatives considered. By way of such earlier realizations it becomes possible to benefit from the income of individual hydraulic installations in the course of planning already, knowing at the same time that the projects concerned will form an inherent part of the final over-all plan. Installations put into operation realizing the hopes fostered will give financial support and exert a marked moral effect on the efficient continuation of the planning work. /Therefore, it is not advisable to wait for the realization so long as the "perfect plan" is prepared, not to mention that no such plan ever exists!/

41. The plan should be broken down to project units and should be executed in such steps that the individual installations economically function, if possible immediately after their commissioning. In other words installations becoming profitable in co-operation with structures envisaged to be realized only considerably later, should not be constructed prematurely.

42. Related branches should be developed most closely /irrigation with drainage, water supply with disposal of sewage and industrial wastes/.

43. Besides requirements and economic evaluation, development programme is strongly influenced by natural conditions and engineering principles the negligence of which may even lead to possible disasters. Some principles to be observed are e.g. that watershed control and storage reservoir construction should be commenced from upstream, whereas that of river training installations should be proceeded from downstream position in upstream direction.

44. In the course of economic investigations, when listing the benefits and disadvantages, it will prove useful to consider quantitatively also factors of minor importance, since the summation thereof may result in substantial changes of aspects. /Thus, e. g. when evaluating the significance of a river canalization scheme, it is desirable to accurately compute the savings in travelling time and fuel consumption of the vessels, obtainable by the possibility afforded for navigation over an impounded stretch/ /13/.

45. For the cost allocation of multi-purpose installations numerous computation methods are known /14/, /15/, /16/, which may frequently lead to highly differing results. It is advisable to conduct comparative investigations and to suggest a uniform method for the economic evaluation of integrated river basin development.

46. When elaborating the integrated river basin development plan, or at the preparation of a national master plan for any country, great care should be exercised not to fix detail so - lutions, lest they become "verities engraved on paper", obstructing the use of scientific and technical advance to be achieved at a later stage.

47. Eventually attention should be drawn to the fact that the realization of an integrated development constitutes a most multifarious task, comprising also numerous questions outside the do - main of water management, which are not of inferior import as compared to those discussed before. In the present study the author considered even the mentioning of the latter beyond his scope of work, in order to better elucidate the selected aspects within the limited space.

Bibliography

/1/ United Nations, Department of Economic and Social Affairs, Integrated River Basin Development /Report by a Panel of Experts/. E/3066, New York, 1958.

/2/ Kanwar Sain, Master Plans for Integrated Water Utilization. Journal of the Institution of Engineers /India/, March 1958.

/3/ Rao, K. L., Engineering Difficulties in River Valley Projects. Journal of the Institution of Engineers /India/, Sept., 1953.

/4/ United Nations, Economic Commission for Asia and the Far East, Proceedings of the Regional Technical Conference on Water Resources Development in Asia and the Far East. Bangkok, 1956.

/5/ United Nations, Economic Commission for Asia and the Far East, Multiple-Purpose River Basin Development. Part 1., Manual of River Basin Planning, New York, 1955.

/6/ United Nations, Economic Commission for Asia and the Far East, Proceedings of the Regional Technical Conference on Flood Control in Asia and the Far East. Bangkok, 1952.

/7/ United Nations, Economic Commission for Asia and the Far East, Multiple-Purpose River Basin Development, Part 2A, New York, 1955.

/8/ United Nations, Economic Commission for Asia and the Far East, Multiple-Purpose River Basin Development, Part 2B. Bangkok, 1956.

/9/ Mosonyi, E. - Pichler, J., Flood Control, Irrigation and Drainage in Hungary's Plain Lands. International Com - mission on Irrigation and Drainage, Annual Bulletin 1961.

/10/ Lampl, H. - Mosonyi, E., Development of Hydraulic Construction in Hungary. Vizügyi Közlemények, Budapest, No. 1954/4. /In Hungarian language with Russian, English and French summaries./

/11/ Mosonyi, E., Master Plan for Water Resources Development in Hungary. Publications of the Technical Department, Hungarian Academy of Sciences, Vol. XIV, No. 4, Budapest, 1954. /In Hungarian language./

/12/ Glesinger, E., The Mediterranean Project. Scientific American, July, 1960.

/13/ Mosonyi, E. - Schilling, F., The Effect of River Canalization on Navigation. XIXth International Navigation Congress, London, 1957.

/14/ Adams, F. L., Allocation of Costs of Multiple-Purpose River Development Projects. XIth Sectional Meeting, World Power Conference, Belgrade, 1957.

/15/ Krutilla, J.V. - Eckstein, O., Multiple Purpose River Development. The John Hopkins Press, Baltimore, 1958.

/16/ Mosonyi, E., Hydrological Design of Large Storage Reservoirs. Budapest, 1948. /In Hungarian language, with English, French and German summaries./

774 E - Oct.1962 - 1,600